Effects of development and implementation of an interactive multimedia computer program on the achievement and attitude of 44 sixth-grade saxophonists were investigated. For 3 weeks, the control group (n = 24) participated in band while students in the experimental group (n = 20) individually worked on the computer program during 8–15 minutes of their daily band class. Following treatment, students and band directors (n = 4) completed attitude surveys. Additionally, students completed written cognitive and videotaped performance assessments subsequently analyzed by two independent judges. Findings indicated that (a) band directors believed that they had covered assessed material in class; (b) experimental students demonstrated significantly higher levels (p < .001) of perceived knowledge and performed significantly better (p < .001) than did control students on written and videotaped assessments; and (c) students and directors indicated acceptance of the computer program. Data suggest that proper development and application of educational multimedia computer programs may benefit instrumental education.

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Effect of Interactive Multimedia Computing on Young Saxophonists' Achievement and Attitude

Instrumental instruction involves the complexity of teaching cognitive, psychomotor, and affective objectives, further compounded by the variety of instruments and the individuality of students. In spite of this obstacle, teachers continually produce students who are quite competent performers; however, some students do not master all the basic concepts necessary for a high level of instrumental performance. Many factors, including restricted time, large class sizes, diversity of concepts among heterogeneous instruments, limited presentation options, and lack of opportunities for individualized tutelage, may contribute to this condition. As an adjunct, multimedia computing might be a vehicle for individual development beyond the limitations of the traditional classroom.

Computers have moved into schools in a relatively short span of

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time, and ensuing research on computer software development and implementation may provide a foundation for the effective use and acceptance of computers in music education. Before the late 1960s, access to computing was restricted to organizations that could afford mainframe computers (McFadden, Price, Eller, & Marsh, 1994). Research and experimentation in computer-assisted music instruction (CAMI) began at universities owning large mainframes. During the next two decades, these schools did significant work in the large-scale development of CAMI, primarily centered on ear training and music theory (Robinson, 1987).

Introduction of microcomputers allowed computers and their associated applications to be more accessible to the general population. Exposure to the benefits of computers rapidly increased their educational use. By 1987, approximately 90% of American schools used computers in instruction (Niemiec & Walberg, 1987). Today many educators view computers less as automated drillmasters or substitutes for human teachers and more as sources of information and feedback helping students create and model the results of their solutions.

Research on program content and general framework suggests that developers may wish to decide what educational "need" they are filling (Fraser, 1985) and support the existing course of study instead of creating a new curriculum (Willman, 1992). After establishing content, Ausubel (1960) found that advanced organizers, such as headings, menus, and overviews, presented before learning, can improve understanding. MacKenzie (1992) advised ending a program with some type of summary, thereby providing a sense of closure.

Research by Gabinger (1993) indicated that participants preferred screen layouts that presented titles at the top, textual information on the left, graphic information on the right, and navigational inputs at the bottom. Display should provide open space, margins, and mixed type sizes and fonts (Castellan, 1983). Color, various type sizes, different fonts, and animation can also be used to emphasize points or relationships (Kidd & Holmes, 1982).

Studies related to subject scope and sequence report that textbooks on instrumental fundamentals are in disagreement on the recommended sequence of material (Allvin, 1971). Fisher (1982) commented that programming a textbook into the computer produces nothing but a moving book. MacKenzie (1992) suggested that assembling and manipulating presentation by "addressing structure and order rather than pushing the information potential of the technology" (p. 424) is a major challenge.

Developers must decide how much latitude to allow students. Learner control has attained widespread popularity; however, indications are that not all students make good decisions about their own learning (Steinberg, 1989). Hannafin (1984) concluded that computer controlled instructional software might be easier and less expensive to produce, since the designer makes all decisions before development.

Simulations, indispensable for meeting many education requirements (Milner & Wildberger, 1974), necessitate learner interaction

through decision making (Rice, 1966), problem solving (Cruickshank, 1966), or role playing (Pollack, 1973). Dittrich (1977) found that a simulation's perceived reality can be more educationally motivating than reality. Thurman (1993) proposes "major elements and interactions in a simulation should conform to the major elements and interaction in the actual system, but [need] not necessarily conform to the actual physical setup" (p. 78).

Choices for feedback include *motivational feedback*, supplying a reward for a correct response (Sales & Williams, 1988), *elaborative feedback*, providing detailed information about the nature of errors (Alessi & Trollip, 1985), and *informational feedback*, giving corrective statements and elaboration of lesson content (Sales & Williams, 1988). Belland, Taylor, Canelos, Dwyer, and Baker (1985) found that learners who selected elaborative feedback best understood the concepts presented. Sales and Williams (1988) concluded students asked for elaborative feedback more frequently than for their grades.

Although not specifically related to computer technology, research on wait time in instruction suggests that increasing the time teachers wait after questioning can stimulate reflective thinking and student involvement. Student responses improve and participation expands with increased wait time (Atwood & Wilen, 1991). At least 3 seconds of uninterrupted silence after questioning seems to enhance student effectiveness in completing cognitive tasks (Stahl, 1994).

Researchers have suggested the optimum time spent on the computer is 20–30 minutes (Lorton, Killiam, & Kuhn, 1975). When a computer program designed to teach math was used, it was found that children having computer access for 10 minutes a day scored significantly higher than those who did not have such access; 20 minutes a day doubled the score (Kulik, Kulik, & Bangert-Drowns, 1985).

Deihl and Radocy (1969) noted that "although teachers are theoretically qualified to teach all the instruments, few can professionally demonstrate them all" (p. 3). Educational software may enhance learning by including high-quality sound and visual modeling for students to emulate.

For this study, I identified a specific area of music education, early saxophone instruction, and attempted to use the most recent technological advances and the established research base to develop an educational interactive multimedia computer program. Implementation and testing followed to determine whether this medium is a viable means of education within the existing instrumental education environment.

METHOD

Program Development

Authorware Professional (Macromedia, 1995) was the authoring language and an IBM 486DX 66 MHz was the hardware used for develop-

ment and implementation of the program created for this study. Pedagogical texts including *Clarinet and Saxophone Experience* (Richmond, 1972), *The Art of Wind Playing* (Weisberg, 1975), *The Art of Saxophone Playing* (Teal, 1963), *Woodwinds Fundamental Performance Techniques* (Saucier, 1981), *How to Care for Your Instrument* (How to Care, 1942), *Guide to Teaching Woodwinds* (Westphal, 1962), *The Look of Music* (Young, 1980), and *Handbook for Making and Adjusting Single Reeds for All Clarinets and Saxophones* (Opperman, 1956) and existing research were consulted to decide the proper program content and organization. Additionally, music educators, saxophone specialists, general wind-instrument educators, educational research and technology experts, and university and public school saxophone students offered advice on program content and presentation.

Program Description

The program is divided into 11 sections—history, family, parts, sound, reed, assembly, care, instrument position, hand position, embouchure, and tonguing—each a part of saxophone pedagogy. The program opens with a video clip of the creation of a cartoon-type character named "Saxman."

Saxman introduces himself and states his purpose: teaching the student about the saxophone. The student begins with a trip to Saxman's library and selects a saxophone book in which the table of contents lists the 11 sections covered in the program and becomes the navigating menu for the entire program. While viewing the table of contents, Saxman receives a telephone call from his friend, a saxophone professor, who provides video and audio demonstrations and instruction throughout the program.

Saxman directs the student to begin the first menu selection; however, the complete menu is active; therefore, any topic may be selected. Each section of the program begins with a cartoon character restating the title of the section accompanied by a clip of music. Prompting during the sign-on procedure asks students to choose whether they would like to resume where they left off or select a different section; however, Saxman does provide the suggested route for completing the program and reappears periodically throughout the program to offer guidance. The beginning and ending of each section show Saxman offering an overview and a summary of the material in that section.

Program Specifics

The average time necessary to complete a daily section of the program is 8 to 15 minutes. The predominant screen layout consists of a title bar centered at the top of the screen, textual information on the left, graphical information on the right, and navigational buttons on the bottom right. Textual information is appropriately limited and uses consistent fonts within sections. Varying presentation techniques require users to solve problems, relate prior knowledge, and deal with

the consequences of their responses. Students encounter simulation techniques within the software and externally by using their saxophone. Multimedia presentation techniques include video, audio, animation, clip art, and photographic images. The order and type of presentation is varied as is the type of feedback. Questions use appropriate wait time with an estimation of time necessary to read the material plus an additional three seconds for processing. The program is mouse-driven except for sign-on procedures.

Design of the Study

Sixth-grade beginning saxophonists ($N = 44$) at four middle schools in a large metropolitan city were administered a survey to decide if they had or would have any saxophone instruction other than their daily band class. Eight students, identified as having had or presently receiving outside instruction, were assigned to the control group. This forced assignment and classes with odd numbers of students resulted in the unequal distribution between the two groups. Therefore, half the students in each beginning band class were assigned to the control group ($n = 24$), and the remaining students in each class were assigned to the experimental group ($n = 20$). The experimental group worked individually on the computer for 8–15 minutes per day during band. The control group participated in daily band activities and had no access to the computer program.

To minimize discussion among peers, experimental-group members were asked not to discuss the computer program until the study was concluded. Students completed computer activities in rooms next to the rehearsal hall in 15 to 17 school days and doubled their computer assignments the day following an absence. Only the first two computer sessions were monitored to be sure students encountered no problems.

Following treatment all students completed Likert-type attitude surveys containing specific response choices modeled after Madsen and Yarbrough's suggestions for surveying the middle-age child (Madsen & Yarbrough, 1985). I varied response descriptors and positive/negative polls in an effort to maintain respondent focus of attention. The control-group survey included questions about perceptions of specific knowledge regarding saxophone performance. The experimental-group survey included the same questions, and additional questions concerning computer usage were also included.

Following an opportunity to view any portion of the program they wished, band directors completed a Likert-type survey designed to find out if they felt the information to be assessed had been adequately covered in band (see Table 1). Band directors responded to a 5-step continuum anchored by "not at all" and "comprehensively." Additional questions related to the band directors' opinion of the program, possible irritants regarding program implementation, and any changes observed in the experimental group.

Several computer assignments ended with a test designed to verify the student had completed the material presented. Students did not

Table 1

Band Director Responses Indicating Perceived Adequacy of Material Covered in Class

Question	Responses						
	Low			*High*			
How well do you think you have covered saxophone...	1	2	3	4	5	*M*	*SD*
... parts?	—	1	—	2	1	3.75	1.25
... tone quality?	—	—	1	1	2	4.25	0.95
... reeds?	—	—	—	2	2	4.50	0.57
... assembly?	—	—	1	—	3	4.50	1.00
... care and maintenance?	—	—	2	—	2	4.00	1.15
... horn and hand position?	—	—	1	—	3	4.50	1.00
... embouchure?	—	—	—	2	2	4.50	0.57
... tonguing?	—	1	—	2	1	3.75	1.25
... family?	—	—	—	3	1	4.25	0.50
Overall	—	2	5	12	17	4.22	0.89

Note. A dash (—) indicates no response.

repeat assignments; however, elaborative feedback related to each incorrect answer was presented.

Students completed a researcher-designed written posttest assessment, including multiple-choice, matching, and short-answer material designed to assess each student's cognitive knowledge about beginning saxophone. Short-answer responses allowed the students additional latitude to account for instructional variations among different band directors and the computer program. This assessment only contained material the band directors believed they had covered; therefore, the assessment differed in form and presentation from material contained in the computer program. Students were asked to write "I don't know" for items they could not answer, providing me some assurance that the student had not accidentally skipped the item. Testing took place during a single band class.

A videotaped posttest, conducted to determine applied knowledge, requested students to assemble their instrument, perform long tones of their choice, and disassemble and put away their instrument as taught. Students were videotaped individually in random order and assigned a number displayed on the tape.

Two professional music educators with degrees in both saxophone performance and music education independently evaluated the written and video assessments. One evaluator viewed part of the computer program during the development stage to offer advice and evaluate the

video, audio, and photographic examples; however, this person did not view the completed program. The other evaluator did not have any knowledge of the program content. Evaluators graded the written tests based on their own independent criteria. Video evaluation involved a researcher-developed checklist in which the evaluators indicated the observed procedure completed by the student and evaluated the acceptability of subjective areas such as proper playing position, tone quality, and embouchure. Independently judged evaluations of the video and written assessment were analyzed using the Pearson product-moment correlation coefficient that indicated an acceptable interjudge reliability of .93 for the written assessment and .82 for the video assessment.

RESULTS

To determine whether the band directors believed they had covered the assessed material in class, I calculated the mean responses and associated standard deviations for the appropriate survey questions (see Table 1). Results indicated that all mean responses were 3.75 or higher on a 5-point scale with an overall SD range of .57 to 1.25. Generally, the band directors seemed to believe they had covered the assessed material.

I calculated student responses on the appropriate survey questions to determine the students' perceived knowledge of the assessed areas (see Table 2). T-tests revealed that computer responses were significantly more positive in all areas except saxophone assembly. Responses to how interested they were in learning to play the saxophone showed a mean (with standard deviations in parentheses) of 4.55 (0.94) for the computer group and a mean of 4.33 (0.91) for the noncomputer group, revealing no significant difference between groups.

Scoring of the students' written and video assessments consisted of a liberal score based on both evaluators' assessment that placed the advantage toward the student. For a response to be counted wrong, both evaluators had to mark that specific response wrong. If either evaluator counted a response correct, the response was evaluated as correct. This procedure allowed latitude for teaching style, presentation, terminology, and interpretations that may have differed from those used in the computer program.

Written and video assessments were analyzed by comparing percentage of items judged correct across groups. Based upon a possible total of 100, noncomputer written scores ranged from 28 to 92, with a mean of 69.14. Computer written scores ranged from 71 to 95 with a mean of 85.47. This difference between groups was significant on the Mann-Whitney U test ($n_1 = 20$, $n_2 = 24$, $p < .001$), with an obtained z of 9.10. Noncomputer scores on the video assessment based on a possible total of 100 ranged from 58 to 93 with a mean of 76.01. Computer video scores ranged from 81 to 100 with a mean of 91.98. This difference between groups was significant on the Mann-Whitney U test ($n_1 = 20$, $n_2 = 24$, $p < .001$) with an obtained z of 10.02.

Table 2
Results of T-Test Analysis of Students' Perceived Knowledge

Question	Noncomputer ($n = 24$)		Computer ($n = 20$)		
How much do you think you know about saxophone...	*M*	*SD*	*M*	*SD*	*t*
... parts?	3.41	0.88	4.45	0.51	4.85**
... sound? (tone quality)	2.95	0.85	4.30	0.65	5.87**
... reed?	3.58	0.97	4.50	0.60	3.81**
... assembly?	4.29	0.62	4.55	0.60	1.39
... care?	3.79	0.93	4.70	0.47	4.18**
... instrument and					
hand position?	4.04	0.90	4.65	0.58	2.68*
... embouchure?	3.04	1.16	4.40	0.50	5.18**
... tonguing?	3.45	0.97	4.35	0.58	3.73**
... family?	3.12	1.12	4.10	0.78	3.39**
Overall	3.52	1.02	4.44	0.60	11.07**

* $p < .01$. ** $p < .001$.

I analyzed experimental student attitude toward the computer program by tabulating individual responses followed by the associated mean and standard deviation (see Table 3). All mean responses were 3.50 or higher on a 5-point scale, with a standard deviation range of 0.58 to 1.33. Overall, the students seemed pleased with the program. When asked if they wanted a personal copy of the program, 16 students (80%) responded yes. When asked if they saw the computer program for sale, and had a computer at home, would they buy the program, 18 students (90%) responded yes.

Results of 12 questions related to the directors' attitude toward the computer program and its implementation showed a strong propensity toward acceptance of the program and its perceived value. None of the directors believed that the students had missed too much of their regular band class, and all the directors indicated they had noticed improvement in the classroom performance and/or attitude of the students using the computer program as opposed to those who did not. All the directors indicated they would adapt their teaching in order to use the program, they would purchase the program if it were available, they thought it would be beneficial to have a program of this type for each band instrument, and they would have each student use the entire program followed by a review of deficient areas.

Table 3
Computer Group Responses Indicating Perceptions of the Computer Program (n = 20)

| | Responses | | | | | | |
| | Low | | | High | | | |
Question	1	2	3	4	5	*M*	*SD*
Did you like the program?	—	—	11	1	8	4.35	0.58
Did the program help you?	—	—	4	7	9	4.25	0.78
Was the program easy to use?	—	—	1	5	14	4.65	0.58
Were you bored while using the program?	10	2	8	—	—	4.10	0.96
Did you miss too much band because of the program?	6	9	4	1	—	3.95	0.99
If you had the program all the time, how often would you use it?	—	1	7	5	7	3.90	0.96
Do you think about things in the program while you play your saxophone?	1	1	3	6	9	4.05	1.14
Do you think the program would have helped students who did not use it?	1	—	—	8	11	4.40	0.94
Was the program better than a book?	—	—	1	8	11	4.50	0.60
Did the program cover more material than you covered in band?	1	—	3	13	3	3.85	0.87
Did you learn more on the program than you learned in band?	1	1	7	9	2	3.50	0.94
Was the material in the program easy to understand?	—	—	1	7	12	4.55	0.60
Did the program help you understand the saxophone and how it works?	—	1	2	8	9	4.25	0.85
Did the program get you interested in in playing the saxophone?	10	5	2	1	2	4.00	1.33
Did the program make band more enjoyable?	1	—	5	6	8	4.00	1.07
Overall						4.14	0.94

Note. A dash (—) indicates no response.

DISCUSSION

Findings in this study suggest that, in this case, multimedia technology was an effective means of instrumental music education, which

does support previous research. Early studies concerning the effectiveness of computer instruction in areas other than music indicated that in general the use of computers produced academic achievement equivalent to traditional instruction when it was used as a replacement (Allvin, 1971; Jamison, Suppes, & Wells, 1974). Later investigations reported that students using computer instruction scored better on objective tests than students who received traditional instruction alone (Kulik, Kulik, & Bangert-Drowns, 1985; Taylor, 1981). Kent (1970) developed and studied the effect of a computer program designed to teach elementary keyboard. He concluded the software was both educationally and economically feasible. Several studies in subject areas other than music have concluded that the use of multiple sensory channels, including graphics, animation, sound, and text, is more effective than the use of a single channel alone (Batino, 1991; Naser & McEwen, 1976; Strang, 1973). In the present study, all subjects had the same amount of classroom instruction except for the 4 hours of computer usage by the experimental group; therefore, results support past research on the instructional timesaving potential of the computer (Allvin, 1971; Avner, Moore, & Smith, 1980; Jamison, Suppes, & Wells, 1974; Robinson, 1987; Thomas, 1979).

One possible reason for the significantly different achievement ratings between groups may be the individualization possible with educational computing. It seems reasonable that students involved in group instruction may not concentrate on the material presented as intensely as they concentrate on the computer presentation due to the individualization of the learning environment. Generally, group instruction may not demand that the student provide timely, individual, and specific responses that demonstrate acquired knowledge. The computer presentation did provide an environment that demanded this and students were aware of this expectation as they interacted with the presentation. Another plausible reason for the enhanced acquisition and application of knowledge by the computer group may be the varied mode of presentation generated by the computer. The addition of video, photographic examples, simulations, animated explanations, professional audio presentation, and direct interaction may have helped enhance the acquired knowledge.

Videotape analysis indicated that computer students were more successful in applying their acquired knowledge than students in the non-computer group. These results, coupled with the written assessments, suggest that students were not only able to learn from the computer but to transfer what they learned to their performance.

Overall results indicated a strong acceptance of the program and its application. Both the band directors and computer students indicated a desire to have and use the program, and there was a perceived educational value for implementation. The only exception involved the two students who said they would not buy the computer program and said they would not care for a personal copy. One of these two students indicated a strong acceptance and perceived value of the computer program based on his/her responses to other questions; the other stu-

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